SPATIAL MODELLING OF QUALITY OF LIFE INDICES FOR SUCCESSFUL IMPLEMENTATION OF DISTRICT MINERAL FOUNDATION WORKS IN MINING AREA OF JHARIA COALFIELD, DHANBAD, JHARKHAND

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1. INTRODUCTION:

The coal mining industry is the back bone of Indian economy. Jharkhand has the largest proved coal reserve in India and second largest state in coal production which shares around 20% coal production of the country. The Jharia coalfield is a storehouse of prime coking coal and fulfills the industrial and domestic needs of the nation since long back. The extraction of coal is inherently associated with risk and hazards, sometimes lead to disasters. The coal mining activities create several socio-economic and environmental problems for the populace living in surrounding area. Many studies report reveals that most of the people including miners at the peripheral of mining areas are living with poor quality of life. Thus, there is a need for assessing the quality of life (QoL) of the people in and around the mining areas in order to investigate the impact of mining on their quality of life for sustainable mining development in the country.

The proposed study is an attempt to contribute towards the delineation of the geographical entity in and around mining area on the basis of Quality of Life for prioritizing implementation of various development schemes under District Mineral Foundation successfully.

2. STATEMENT OF THE PROBLEM:

Quality of life (QoL) may be defined to be the general well-being of individuals, families and societies, outlining negative and positive features of life. It observes life satisfaction, including everything from physical health, family size, education, employment, wealth, safety, and security to freedom, religious beliefs and environment. Focusing the Quality of life of the people living in and around the mining areas, one can explicitly notice the worst condition of their living environment. Although the mining and industrial developments generates employment opportunities among the people in and around the mining areas and infrastructures such as schools, colleges, hospitals, communicating roads, clubs, libraries are created urbanizing the areas, on other hand, its impact on the environment, socio-economic, culture, psychological state, health, sanitation, vegetation and soil is very significant.

But, the Quality of Life of the people in mining areas are ruined out by water, air and noise pollution and land degradation, deforestation and damage to groundwater aquifers caused by mining operations. As the Mining Industries are responsible for the damage of people's Quality of Life in terms of their socio-economic, health and sanitation, the Government has to come forward to sustain the community development by compensating them through social development programs and specific need based plan.

District Mineral Foundation: In view of interest and benefit of persons, and areas affected by mining-related operations, District Mineral Foundation (DMF) Trust, a statutory trust established as a non-profit body by the Government in all districts affected by mining or mining related operations in 2015. DMF works have mainly related to drinking water supply, sanitation, health, education, welfare of women and children, welfare of aged and disabled, skill development, environment preservation, pollution control measures along with physical infrastructure such as irrigation, energy, watershed development etc. The proposed study will also contribute towards successful implementation of various activities as required locally under District Mineral Foundation Trust of Dhanbad in the study area.

3. STATE-OF-THE-ART:

Many scientific studies address on the impact of coal mining on Quality of Life of the people in coal mining area. The health, socio-economic condition, culture, psychological state and the environment have become very much unfair to lead a satisfied life. The sanitation status is not up to the standard of healthy environment and also causes malaria and other water- borne diseases. Many farmers had to give up their agricultural land and their farming due to development of mining industries. Moreover the natural resources such as productivity of agricultural lands, groundwater quality, and vegetation are significantly degraded with toxic contamination due to mining activities. A few major aspects of quality of life in the study area are reviewed and described in subsequent section under below.

Environmental aspects: Coal mining has several major adverse effects on the local environment and society **(Goswami, 2015)**[1]. Mining adversely

affects the ecosystem of the entire study area **(Pandey et al., 2016)[2]**. The wildlife and habitats are disturbed due to mining activities **(MOEF, 2009, Bhati et al, 2016)[3]**. The environmental pollution caused by coal mining activities badly affects air, water and land **(Priyadarshi, 2010)[4]**. The product of combustion due to coal fire liberates huge amounts of toxic and obnoxious gases as well as GHGs, contributing to global warming and affecting the quality of life in the long run **(Khanna, 2013; Pal et al., 2011)[5]**.

Health Aspects: Several occupational problems and noise problem are almost everywhere in mining areas and it is generated by different mining activities **(NIOSH, 2011; Hessel, 1987; Frank et al., 2003)[6]**. Diseases like respiratory, allergy, heart and lungs problem, problem related to nervous system Silicosis, pneumoconiosis and cancer etc., are common in coal mining areas **(Pone et al., 2005; Antao, et al. 2005; Hurley et al., 1987; Green et al., 1996; Buchanan et al., 2003 Roscoe et al., 1989, Cowie and Mabena, 1991; Blackley et al., 2014)[7]**

Social and Economic Aspects: The socio-economic condition of the miners is considerably weak due to large number of unskilled and illiterate laborers, and their low- income. Mine employees separated from their families and communities during work periods and migrated to other cities established due to function of mining industries. Migrant placements are also common in mining areas and the associated psychosocial hazards have recently been reviewed **(Hansen, 1993)[8]**. Most of the people living in and around the mining areas go through depression as they are unable to meet the daily requirements of their children and family as there occurred a diversion in their profession.

Consequently, they are habituated and addicted as they are charmed by alcohol and other drugs. They seek an alcohol to release their mental stress and as a result, they become addicted to drugs, which cause several societal problems. This situation might have a direct impact on the productivity of the industry.

Displacement Aspects: Due to mining activities in the study area, several residential villages and dwellings were displaced to another nearby area without proper rehabilitation plan. So, most of them were deprive of basic needs of life **(Pal et al., 2011)[9].**

3. STUDY AREA:

A part mining area of Jharia coalfield (JCF) in Dhanbad district of Jharkhand in India would be selected for the proposed research study and the study area is located between latitude 23°41'00" to 23°49'00' N and longitude 86°21'00" to 86°29'00" E **(Sarkar et al., 2007; Gupta et al., 2013)[10]** JCF is the most exploited coalfield for the past more than 100 years because of available metallurgical grade coal reserves. It has an elevation of 745 feet (227 m), a total area of about 450 sq km and belongs to Gondwana group of Permian age **(Fox, 1929)[11]**. This has Barakar, Barren Raniganj, Talcher measures **(CIMFR, 2012)[12]**. Dhanbad City has a humid and hot climate. The region experiences sub–tropical climate. It is cool during winter season from December to February and temperature fall between 11-22 °C. During the month of May have been the hottest, temperature rises up to 48°C and several a times the high degree of temperature is accompanied by high humidity, average temperature lie 19-40 °C during summer season. During month of October and November, the average temperature lies from 16-31 °C. The rainy season continues from middle June to September and average annual rain has become approximately 1300 mm in Dhanbad.

The people living in and around the coal mines of JCF are with problems associated with mining operations. Water scarcity is major issue as the ground water levels at different villages have already gone down and the wells and tube-wells are found dried. The mine quarries, overburden dumps, underground tunnels and surface area are physically, chemically and biologically imbalanced due to mining operations and have caused contaminations in surface and groundwater quality and soil quality. People are facing the problem of water scarcity both in quality and quantity. Beside the water pollution, the problems of noise and air pollution in the mining area are significant. The whole land surface looks black or brown in color. The dust deposit on the plants and buildings and other receptors is visible. The visibility of the mining area is very poor due to the presence of particulate matters in the air. This impacts quality of life of the study area.

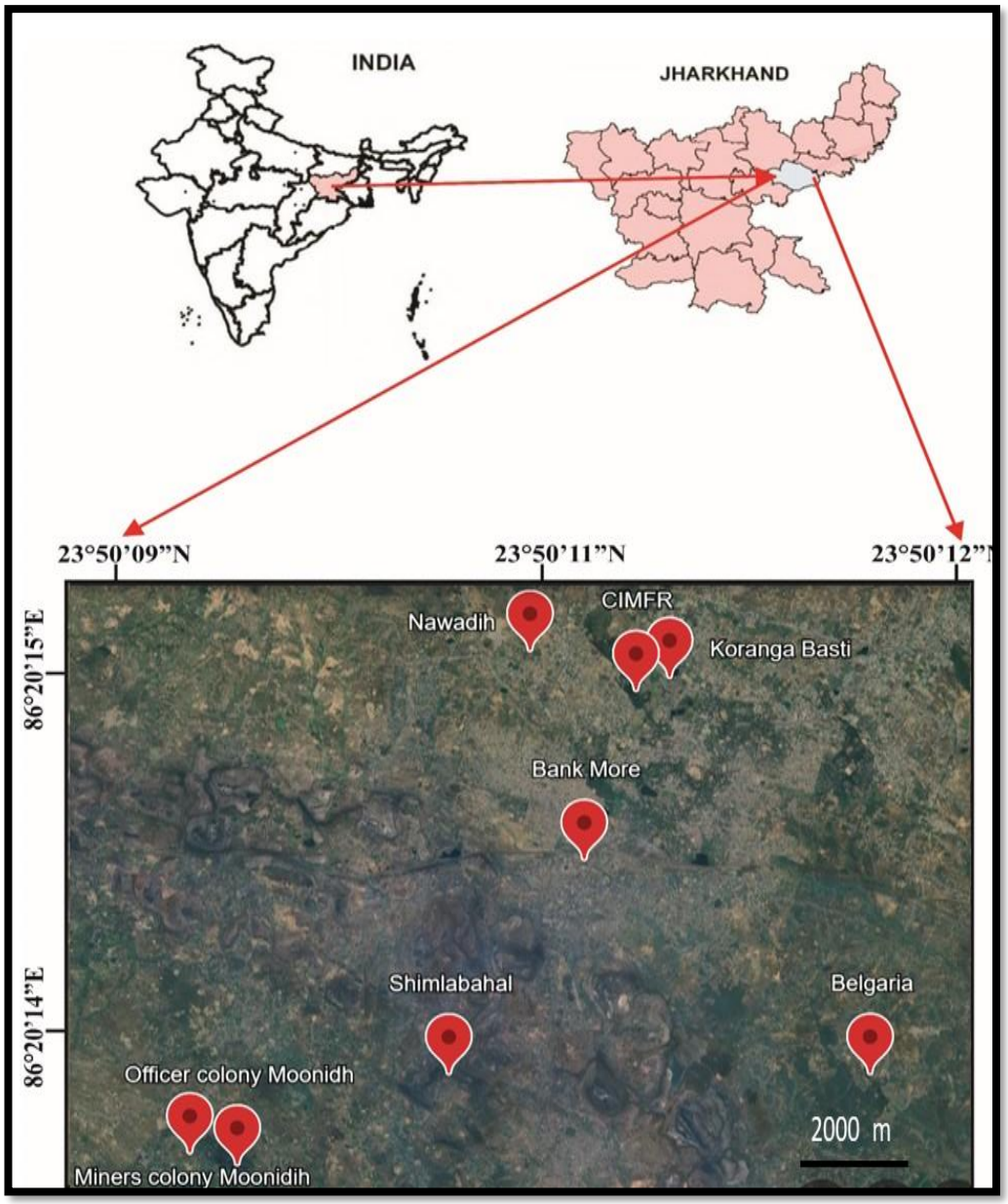


Fig:1, Location Map of the Study Area

5. PROBLEM TO BE INVESTIGATED:

The proposed study will concentrate on investigating followings problems:

I. It will discover the geographical characteristics of the study area as a background material.

II. It will inspect the consistency of geographical delineation using fuzzy-based spatial modelling.
III. It will compute the Quality of Life Indices of the families within the selected geographical domain.

IV. It will examine the principles and mechanism of the proposed approach in implementing various development schemes under District Mineral Foundation Trust.
V. It will find out the hurdles to successful implementation of District Mineral Foundation work.

6. OBJECTIVES OF THE STUDY:

The broad objective of the proposed research work is to study on the Quality of Life (QoL) of the people living in and around a mining area in order to devise appropriate social development plans for geographically classified area based on Quality of Life (QoL) indices under District Mineral Foundation (DMF) as one of the tasks of sustainable mining practices. The following tasks would be carried out in order to achieve the above objective:

I. To construct the QOL indices in the eight domains in the study area.

II. To develop an appropriate model for computing QoL indices based on various parameters of the considered major domains.
III. To carry out a spatial modelling of QoL indices and delineate the geographical area on the basis of QoL of the people.
IV. To devise appropriate social and other development plans under DMF for a sustainable mining practice.

7. HYPOTHESES:

The hypotheses covered for this proposed study are as under:

I. The Quality of Life (QoL) of a family can vary with respect to the degree of development of its geographical location.
II. There may be a good correlation of QoL with geographical locations.
III. The delineation of geographical entity subject to the QoL of the families located therein will be helpful to distinguish the families of lower state

from higher state.

Thus, the proposed approach with above discussed hypotheses may be more effective for implementing various schemes under DMF than the conventional method.

8. RESEARCH QUESTIONS:

I. What is the advantage of Spatial Modelling based on QOL indices for successful implementation of DMF works in a mining area?
II. What are the major domains of the QOL indices?
III. How geographical area delineated on Spatial Modeling based on QOL indices play significant role in devising welfare works.
IV. How an appropriate social and other welfare plan can be developed for DMF and sustainable mining practices.

9. RESEARCH DESIGN AND METHODOLOGY:

The QoL will be assessed based on the selected domains, namely social, economic, cultural, psychological, sanitation, health, living environment and working environment (Total eight domains).The variable of the domains will be identified after a field visit and interaction with the people on the common and prevailing issues in the community as it is one of the objectives of this proposed research. However, some of the important variables will be taken to measure as follows:

I. **Social:** Life Expectancy, Sex Ratio, Family size, marital status etc.
II. **Economic:** Income, Number of working members, private or govt., house structures (Packa/Kutcha), Transport facilities availability etc.
III. **Cultural:** Religion, caste, festival, attire, Veg. / Non- Veg. etc.
IV. **Psychological:** Different attitudes to explored and identified as variables, addiction if any, mental retardness etc.
V. **Sanitation:** Neatness, availability of toilets, position or location of Cow-sheds, drainages, water-loggings etc.
VI. **Health:** Diseases who outbreak suddenly like Malaria, Typhoid, Corona etc. with other diseases like Cancer, AIDS, Skin diseases etc.

VII. **Living Environment:**

a. Air Pollution parameters such as PM_{10}, $PM_{2.5}$, SO_2, NO_2 etc.
b. Water Pollution- TDS, TSS, pH, Fe, Ca, Pb etc.
c. Noise level

VIII. **Working Environment:**

a. As above (Environment)
b. Nature of job
c. Behaviour of Higher Official etc.

9 .1 **Type of Research:**

Different methods already used for assessing quality of life, an approach for computing integrated quality index has been developed by **Sundararajan and Loveson (2002**) for assessing integrated environmental quality of the entire environmental system. But in the present study a **cross-sectional survey** of selected house hold will be done to assess the

existing status of population and their quality of life Status. An innovative approach would be adopted to develop a modified formula for assessing the integrated Quality of Life (QoL) Indices of the people considering **eight major** domains as social and economical status, cultural and psychological effects, sanitation and health condition, living and working environments. This model assumes each family as a system and each domain of QoL would be treated as sub-system built up with multiple parameters for assessing the integrated quality index of the each domain. Major parameters of the chosen domains for evaluating QoL of the families would be identified from many existing research articles and other resources available nationally and internationally. A fuzzy set Ã= [a, b, c, d] would be defined consisting of the standards and also a trapezoidal fuzzy membership function $\mu_A(x)$ would be defined on each fuzzy set. A fuzzy-based computer algorithm would be developed to evaluate the QoL of the families living in and around mining area. The quality index and the impact index with respect to the individual parameter will be defined from fuzzy number generated through its corresponding membership function. The overall quality of the family would be estimated by integrating together using appropriate numerical technique as an index, namely integrated quality of life

(IQoL) or simply QoL. The Integrated Quality of Life index would be kept with a scale to vary from 0 to 100 and the family may be considered to have minimum requirements in all respects if its score is at least 50.

9.2 Research Method:

As the present study is concern with Survey with investigating and developing spatial modeling of QOL indices for improving quality of life in Mining area of Jharia Coal field of Dhanbad district in reference to developmental works under DMF **Survey and observation method** will be used to gather related data while the overall quality of the family would be estimated by integrating together using appropriate numerical technique as an index, namely integrated quality of life (IQoL) or simply QoL. The Integrated Quality of Life index would be kept with a scale to vary from 0 to 100 and the family may be considered to have minimum requirements in all respects if its score is at least 50.

9.3 Data Base and Sampling:

Both primary and secondary data sets have to use in the study and will collected from primary as well as secondary sources -

- **Primary Data:** Primary data will be collected from sample process. As the Study area is comprises of 10 Community Development Block comprises of thousands of villages.

- A random sampling will be done in for selecting mining area and households to collect the primary data. Primary data will be collected through following tools-
    i. **Questionnaire**
    ii. **Socio-economic Survey**
    iii. **Careful observation, and**
    iv. **Interview of stakeholders**
- **Secondary Data:** Secondary data will be collected from variety of sources such as –
    i. **The Census of India**

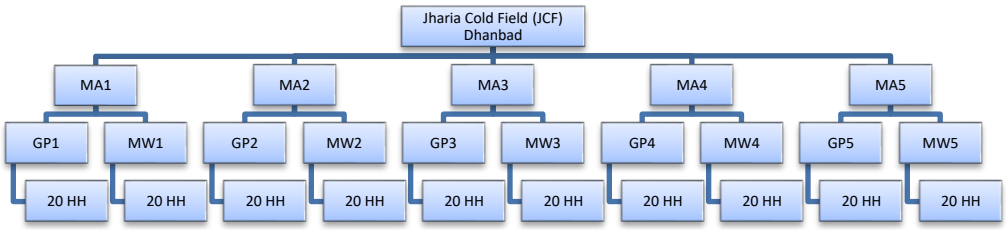
ii. **The geographical data(Topographical Sheet and Survey Map)**

iii. **Relevant government agency publications Central and State, District Gazette etc.**

iv. **Routine data collected by state and central agencies.**

These secondary sources will be cross checked and justified with the data collected through primary sources.

- **Sampling Design:**



References: MA – Mining Area; GP- Gram Panchayata
MW- Municipal Ward; HH – House Hold

9.4 Preparation of Thematic Maps:

The computed Integrated Quality of Life indices would be evaluated and categorized in different classification such as excellent, very good, good, satisfactory, fair, moderately fair, poor, very poor by grouping the families that possesses IQoL indices in different classified ranges. The statistical analysis of Integrated Quality of Life indices of the people living as a small group in different villages or residential complexes provided by the companies for their employees such as mean, mode, range, minimum and maximum values will be carried out with its corresponding geo-references. The data would be interpolated with appropriate methods and delineated into different classifications using Geographical Information System (GIS). Different thematic maps pertaining to Integrated Quality of Life and its different influencing parameters of the considered domains would be prepared with multi-colored visual effects. The reasons for certain geographical area to have low values of quality of life of people would be investigated from the output of the model. A complete diagnostic report would be prepared and the impact of mining on the people Integrated Quality of Life would be assessed in terms of degree of

damage in the domains of Integrated Quality of Life through appropriate statistical approach.

10. CONTRIBUTION TO EXISTING KNOWLEDGE:

The geographical areas should be delineated and categorized into different classification so that appropriate development activities may be devised for distributing the available fund under District Mineral Foundation (DMF) in order to bring a significant improvement in Quality of Life of the people through sustainable mining practices. The proposed scientific study will serve the District Mineral Foundation work implementing agency as a Site Specific Action Plan and guideline for utilizing the Fund properly prioritizing the delineated geographic entities with the available fund.

11. SIGNIFICANCE OF THE PROPOSED WORK:

In the recent years, District Mineral Foundation Trust, Dhanbad has spent its fund mainly on flyover, water supply programs, Street Light etc. But using the proposed approach, the various development activities under DMF can be implemented more effectively distributing the fund as per the requirement of the families located under different classified area based on their Quality of Life. The Quality of Life indices would help the officers of the Administration concern with implementing DMFT activities to identify the major issues of each village in and around mining area, and prepare a site specific action plan and also as guidelines to utilize the fund reasonably prioritizing the delineated geographical entities. The results and recommendations may also be useful for Corporate Social Responsibility (CSR), District Rural Development Agency (DRDA) and other the district development fund.

12. FUTURE WORK:

The proposed approach can be applied for assessing the Quality of Life of the families around any kind of industries, educational institutions, and organizations for implementing different developmental activities under District Mineral Foundation. The approach can be used to assess the Quality

of Life (QoL) of the each family in the country if a detail survey is carried out along with senses for each consecutive decade, the Government authorities can properly utilize the fund allotted to the states as per the need of the people living at different classified geographical area on priority basis. The approach would be useful to avoid misuse of fund in unwanted activities. Once the data is available, the future researchers can select a study domain and carry out the study on QoL of the people and analyze the results prepare their dissertation work with recommendations to achieve the societal mission oriented objectives of their research, which would also be useful for the concern authorities.

13. TENTATIVE CHAPTERS:

Chapter-I : Introduction –In this chapter, concept of Quality of Life, principles of indexing methods and its advantages, application of fuzzy logic, role of spatial modelling and notion of District Mineral Foundation (DMF) will be dealt.

Chapter-II: Review of Literature –This chapter will present a review of related literature available from different sources innational and international levels on QoL Indexing techniques, fuzzy application in Quality of Life study, Spatial Modelling and origin and concept origin and functions of DMF.

Chapter III: Research Methodology - This chapter will present the details of the objectives of the study along with size of the sample, selection of tools, statistical resources used for analysis and interpretation of data collected.

Chapter IV: Analysis of the Data, Results and Interpretation –In this chapter, the analysis of the data, results obtained and the scientific interpretation would be presented.

Chapter V: Conclusion and Recommendations - The investigations, results and findings of the study will be summarized as a conclusion of the study. The suggestions and recommendations for future research along with the limitations of the study will be presented.

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